

METHOD AND APPARATUS FOR ESTIMATING THE LINK QUALITY OF A COMMUNICATION CHANNEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and an apparatus for estimating the link quality of a channel, and more particularly to a method and an apparatus to utilize a fading value to modify an estimated link quality thereby deriving a quality measure being close to the actual quality of said channel.

2. Description of Related Art

In a wireless communication system, the link quality of a channel is an essential reference parameter whether for the transmission party or the reception party. For example, if the link quality between an access point and plural nodes covered by said access point is able to be precisely measured, the MAC layer (media access control layer) of said access point can properly switch the communicating channel among the plural nodes or decrease/increase the signal transmission rate.

Basically, link quality is determined upon the measured signal-to-noise ratio (SNR). Although the parameter is useful in evaluating the link quality of a communication channel, it has been found that the precise link quality is hard to be represented merely by an SNR. Some additional factors, such as the fading factor resulted from the multipath, may possibly affect the accuracy of the measured quality.

Accordingly, it is desirable to provide a new method and an apparatus for estimating a link quality of a communication channel.

SUMMARY OF THE INVENTION

An objective of the present invention is to provide a novel method and an apparatus for estimating the link quality of a communication channel, where the fading factor caused by the multipath transmission is addressed to modify the estimated quality value.

To achieve aforementioned objective, the method in accordance with the present invention mainly comprises the steps of:

estimating a noise quantity (B) of said channel based on two long training symbols contained in a received OFDM packet transmitted over said channel;

summing the absolute values of estimated subcarrier gain values (H_k) of said subcarriers thereby obtaining an estimated channel gain value (A) of said channel;

estimating a fading value (F) of said channel based on said estimated subcarrier gain values; and

subtracting said fading value (F) from said estimated channel gain value to derive a channel gain measure (A-F), whereby the link quality of said channel is defined as a ratio of the actual channel gain value to the noise quantity (B).

Other objects, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows gain values of all subcarriers according to the first long training symbol of the present invention;

Fig. 2 shows gain values of all subcarriers according to the second long

1 training symbol of the present invention;

2 Fig. 3 is a schematic view showing the estimated subcarrier gain value H_k
3 for all subcarriers; and

4 Fig. 4 is a block diagram of a link quality estimating apparatus in
5 accordance with the present invention.

6 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

7 The present invention is to provide a novel method and an apparatus for
8 estimating the link quality of a communication channel over which OFDM
9 (orthogonal frequency division multiplexing) packets are transmitted. As well
10 known in the art, the head of an OFDM packet includes a PLCP (physical layer
11 convergence protocol) segment in which ten short symbols and two long
12 symbols are contained. In the present invention, the two long training symbols
13 are utilized to estimate some parameters for determining the link quality. It
14 should be noted that said channel is deemed as being composed of N subcarriers
15 and each of which represents a specific frequency. For instance, the 802.11a
16 channel has a total of 64 subcarriers, wherein 52 of the 64 subcarriers are used
17 the most.

18 With reference to Figs. 1 and 2, when said two long training symbols of an
19 OFDM packet are sequentially transmitted over the channel, gain values of each
20 subcarrier is measured. The subcarrier gain values are designated with
21 $(H_{1,1} \dots H_{N,1})$ and $(H_{1,2} \dots H_{N,2})$. The first suffix (1 to N) indicates the ordinal of the
22 subcarriers and the second suffix (1 or 2) represents that the measured subcarrier
23 gain value is observed based on the first or second long training symbol. For an
24 ideal communication channel, there should be no noise and thus the measured

1 subcarrier gain values ($H_{1,1} \dots H_{N,1}$) upon the first long training symbol are
 2 respectively identical with the measured subcarrier gain values ($H_{1,2} \dots H_{N,2}$)
 3 upon the second long training symbol. Accordingly, it is realized that the noise
 4 quantity is measurable in an actual channel while a difference exists between two
 5 measured subcarrier gain values ($H_{k,1}$ and $H_{k,2}$) as shown in Figs. 1 and 2.

6 Therefore, the noise quantity (B) of said channel is estimated by summing
 7 the absolute values of the all difference values between two respective subcarrier
 8 gain values ($H_{k,1}$ and $H_{k,2}$), as represented by the relationship $B = \sum_{k=1}^N |H_{k,1} - H_{k,2}|$.

9 Moreover, to obtain a measure that is much closer to the actual gain value of
 10 the subcarrier, the aforementioned two parameters are further averaged to
 11 calculate an estimated subcarrier gain value H_k as shown in Fig. 3. The
 12 calculation for the estimated subcarrier gain value H_k is as shown by the equation
 13
$$H_k = \frac{H_{k,1} + H_{k,2}}{2}.$$

14 By summing up all the absolute values of all estimated subcarrier gain
 15 values (H_k) of all subcarriers, the entire channel gain value (A) is obtained. The
 16 estimation of the channel gain value is expressed with an equation $A = \sum_{k=1}^N |H_k|$.

17 In order to represent the influence on the channel resulted from the
 18 multipath, a fading value (F) is further taken into consideration. The fading value
 19 is derived by the relationship $F = \sum_{k=1}^N \left| |H_k| - \frac{A}{N} \right|$ in which the ratio of the estimated
 20 channel gain value (A) to the total quantity of the subcarriers (N) stands for an
 21 average subcarrier gain value for each subcarrier. Actually, the difference in
 22 quantity between the estimated subcarrier gain value H_k and the average
 23 subcarrier gain value $\frac{A}{N}$ can be deemed as a deviation. Therefore, the fading

1 value (F) for the channel can be calculated simply by accumulating the absolute
2 values of all deviations.

3 As described above, parameters including the estimated channel gain value
4 (A), the fading value (F) and the noise quantity (B) of the channel are all
5 calculable based on the subcarrier gain values $H_{k,1}$ and $H_{k,2}$. After said three
6 parameters (A, F, and B) are obtained, the link quality (LQ) of the channel can be
7 defined as $LQ = \frac{(A-F)}{B}$. As shown in the link quality equation, if the fading

8 value is not taken into account, only the ratio of parameter (A) to (B) is
9 considered, which substantially represents a signal-to-noise ratio of the
10 evaluated channel. However, since the fading value is provided in that equation,
11 even when a channel has great variation in channel gains, the link quality can
12 very precisely be estimated according to the method of the present invention.

13 Moreover, the link quality estimating method described above is able to be
14 implemented with such an apparatus as shown in Fig. 4. The apparatus includes a
15 channel gain estimating means (10), a calculating means (20) and a link quality
16 calculating means (30).

17 The channel gain estimating means (10) is for estimating the first and the
18 second subcarrier gain values ($H_{k,1}, H_{k,2}$) for each subcarrier based on said two
19 sequentially received long training symbols of a received OFDM packet.

20 The calculating means (10) computes the noise quantity (B), the fading
21 value (F) and the estimated channel gain value (A) based on foregoing equations.

22 With the calculated parameters, the link quality calculating means (30)
23 further computes the link quality (LQ) of the channel upon the relationship
24 $LQ = \frac{(A-F)}{B}$.

1 In conclusion, the purpose of the present invention is to introduce a fading
2 value to modify the estimated link quality thereby considering the real
3 conditions of the estimated channel.

4 It is to be understood, however, that even though numerous characteristics
5 and advantages of the present invention have been set forth in the foregoing
6 description, together with details of the structure and function of the invention,
7 the disclosure is illustrative only, and changes may be made in detail, especially
8 in matters of shape, size, and arrangement of parts within the principles of the
9 invention to the full extent indicated by the broad general meaning of the terms
10 in which the appended claims are expressed.